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(54) Improvements relating to fuel/air pre-mixed burners

(57) A gas burner (10) is provided comprising a plurality of annular plate elements (14) stacked to form at least a part of the burner body and to define therein a hollow interior (16). A combustible gas/air mixture (20) is supplied to the interior of the burner through one end of the stack and optionally said supply is fan (22) assisted. The plate elements are stacked together in adjacent fashion but are separated from one another by protrusions provided on one side of the plates which are received by recesses provided in adjacent plates which are of a depth less than that of the protrusions. Thus not only are the plates separated from one another to define a plurality of passages (32) which lead in a direction transverse to the stack height from the interior to flame ports (34) on the outside of the body and through which the combustible gas/air mixture can flow, but the protrusions and recesses provide an extremely convenient means of assembling the burner.

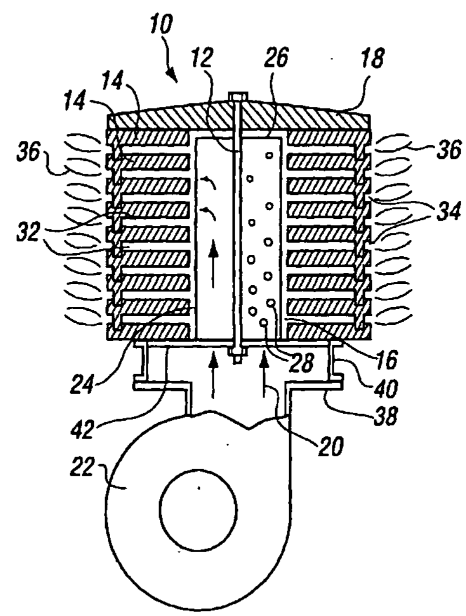

FIG 1

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Description

[0001] This invention relates to pre-mixed burners which are used for example in water heating boilers and other heating devices.

[0002] Certain burners are called fully pre-mixed because the fuel, usually gas, and a quantity of air equal to or exceeding the stoichiometrically correct amount of air to support the combustion of the fuel, are supplied and are mixed to produce a combustible mixture which subsequently is ignited to produce a burner flame which, in the case of heating the water in a boiler, is applied to a heat exchanger of the boiler. The term pre-mixed arises therefore because of the mixing of the fuel and air before the ignition. There are other types of burner which operate in a mode in which a sub-stoichiometric amount of primary combustion air is mixed with the fuel before ignition, and secondary air, required for completing the combustion process, is supplied to, or more usually induced into, the flame after ignition of the fuel/primary air mixture. These other burners are known as partially pre-mixed burners. The present invention may be applicable to such burners, but its best application is to the fully pre-mixed type, as partially pre-mixed burners are being used less and less because they are rather inefficient and generate high levels of nitrogen oxides (NOx) during the combustion process.

[0003] The present invention is concerned with a burner of the type adapted to fit inside the boiler heat exchanger, the latter being of a generally cylindrical construction with the water pipes defining the generally cylindrical construction. Accordingly, although not strictly necessary, the burner will be of a generally cylindrical construction, to ensure that the flame which exists around the circumference of the burner will be applied evenly to the water tubes for the heating of the water therein.

[0004] An example of a burner which is adapted for use in a circular type heat exchanger is set forth in European Patent Application No. 0816757 A2, but in that design the burner body is made up of ceramic plates extending axially of the burner and grouped to form a hexagonal shape in section. As can be appreciated, the burner flame across each side of the hexagon, is at a varying distance from the adjacent water tubes if they are arranged in the cylindrical manner set forth above, and there will be differential heating of such tubes.

[0005] Boilers having cylindrical heat exchangers are becoming more popular as heat transfer to water or air is required to become more efficient, and more particularly the use of such a construction enables the boiler to be located in less space, which is always desirable. Also, as boiler efficiencies and range of operation increases, many boilers now are condensing boilers, which means that so much of the available heat is extracted from the combustion products, that there is generated a considerable amount of condensation, which must be collected and disposed of. Boilers with the cylindrical heat exchangers enable that to be done effectively.

[0006] German Utility Model Application No. DE19704985 to Vaillant describes such a cylindrical burner being essentially comprised of a plurality of superposed metal discs which are provided with radial formations on their surfaces which when contiguous with corresponding radial formations on adjacent discs define gas mixing channels therebetween. Additionally, the metal discs are annular and when clamped together define an inner cavity of the burner into which the fuel-air mixture is introduced before being urged through said gas mixing channels which emerge on the outer surface of the burner.

[0007] The present invention is concerned with a burner which is adapted to be used in a boiler which has a generally cylindrical heat exchanger (such boilers are also known as boilers with "wrap round" or axi-symmetric heat exchangers), but wherein the burner is constructed so as not to suffer the problem which is present in the prior art arrangement discussed above.

[0008] Usually, the fuel/air mixture will be gas and air, but it is again possible, although unusual, to use a liquid fuel/air mixture. In the interests of simplicity of description, reference will be made hereinafter only to gas and air as providing the mixture, but it is intended that liquid fuel and air mixtures be covered.

[0009] According to the invention there is provided a gas burner comprising a plurality of annular plate elements stacked to form at least a part of the burner body and to define therein a hollow interior, said interior being adapted to receive a combustible gas/air mixture supplied through one end of the stack, the stack defining a plurality of passages which lead in a direction transverse to the stack height from the interior to flame ports on the outside of the body, characterised in that the plate elements are provided with a plurality of protrusions on one surface having gaps therebetween, said protrusions co-operating with the surface of an adjacent element to at least partially define the flame ports, and in that the protrusions separate adjacent plate elements from one another.

[0010] Preferably the plate elements are substantially planar on one suraface.

[0011] Preferably, the protrusions are disposed substantially annularly on one surface of the element.

[0012] Preferably, the substantially planar surface of the element is provided with recesses which can receive the protrusions of an adjacent element to correctly orientate adjacent plate elements with respect to one another.

[0013] Further preferably the depth of the recesses is less than the height of the protrusions so as to provide a separation distance between adjacent plate elements and define the transverse passages and/or the flame ports through which the gas/air mixture can flow.

[0014] The plate elements preferably are made of heat resistant ceramic material, and the plate elements may be pressings, castings (preferably freeze castings)

or machined items. The passages may be defined jointly by adjacent elements when they are stacked. For example, the plate elements, which may be identical for ease of production, may have feet on one side and recesses on the other side, in which the feet of the adjacent element sit, but the feet being of a length greater than the depth of the recesses, so that the elements are stacked but spaced one relative to the other, so that the passages are formed therebetween. The number of feet may be varied to vary the size and number of the passages and flame ports.

[0015] Any appropriate arrangement, of which there are a vast number, for defining the passages and ports, may be adopted.

[0016] At the other end, the stack may be closed, by a closure cap, and the elements may be held together in any suitable manner, for example by using a through bolt arrangement of the type set forth in the said European Application.

[0017] The elements are preferably circular in shape, so that the stack outer surface is circular, whereby a cylindrical flame is established when the burner is in use. Such a flame in practice will be short, with low emission of NOX. The use of ceramic material for the elements means that the elements will withstand higher surface temperatures than metals, permitting higher turndown ranges of operation, and also lower primary aeration, enabling higher thermal efficiencies.

[0018] The burner is preferably fan powered for the supply of air for the combustible mixture.

[0019] The edges of the elements preferably are shaped or profiled to eliminate eddy current shedding from the gas/air mixture at the port edge and minimize combustion resonance, as set forth in our copending European Application No. 0810404 A2.

[0020] The interior of the body may include a distributor, to ensure that the gas/air mixture is evenly distributed throughout the length of the stack, so that as far as possible, even amounts of gas/air mixture reach all of the passages and flame ports throughout the height of the stack. Such a distributor may comprise a perforated metal tube having an open end and a closed end, the open end being located at the end at which the gas/air mixture is supplied to the interior, so the mixture is initially supplied to the inside of the distributor tube, from whence it emerges into the interior of the body before being forced through the passages to the flame ports.

[0021] Alternatively, effective gaseous distribution may be achieved by providing protrusions on a surface of the element around annuli thereon of two different radii such that the protrusions disposed in the annulus of greater radius at least partially define the flame ports on one side and define a substantially annular gas distribution channel with the protrusions disposed in the annulus of lesser radius.

[0022] Effective gaseous distribution may be also achieved by staggering the protrusions of one annulus relative to the other, or by varying the size of the gaps between the protrusions disposed in one or other of the annuli. Preferably the gaps between the protrusions disposed in the annulus of lesser radius are larger than those disposed in the annulus of greater radius.

[0023] Thus not only are the plates separated from one another to define a plurality of passages which lead in a direction transverse to the stack height from the interior to flame ports on the outside of the body and through which the combustible gas/air mixture can flow, but the protrusions and recesses provide an extremely convenient means of assembling the burner.

[0024] Embodiments of the invention will now be described with reference to the accompanying drawings, wherein;-

Fig. 1 is a sectional side view of a burner according to a first embodiment of the invention;

Fig. 2 is plan view of one of the plate elements of the burner shown in Fig. 1;

Fig. 3 is a plan view of a connector disc used for coupling the elements together:

Fig. 4 is a view similar to Fig. 1, showing a further embodiment of the invention;

Fig. 5 is a view similar to Fig. 1 showing yet a further embodiment of the invention;

Fig. 6 is a detail showing how the elements may be profiled at their outer edges for eddy shedding and resonant noise minimization;

Figure 7 shows a schematic perspective view of an alternative configuration of plate element, and

Figure 8 show a sectional view of a pair of elements of the type shown in Figure 7 stacked on top of one another.

[0025] Referring to the drawings, in Fig. 1 is shown a burner 10 which is a cylindrical assembly having its axis centered on holding bolt 12.

[0026] The assembly is made up of a plurality of plate elements 14 of identical construction, these elements being flat discs and being annular in nature so that the holes in the center of the plates together form a burner interior 16. That interior 16 is shown in Fig. 1 and is closed at one end by means of a cap 18, whilst at the other end the interior is opened to the supply of a fuel air mixture as indicated by arrows 20, from a powered fan 22.

[0027] Inside the interior 16 is a distributor cylinder 24 which may be metallic in nature, and it is closed at the opposite end of the burner as indicated by reference 26, but the wall is perforated as indicated by reference 28 so that the fuel air mixture 20 is initially pumped into the

distributor 24, and escapes through the perforations 28 so as to be evenly distributed throughout the interior 16 of the assembly of plate 14.

[0028] The plates 14 as shown in Fig. 2 are provided with feet 30 on one side, whilst on the other side they have recesses to receive the basis of the feet of an adjacent plate element 14. The feet are longer than the depth of the recesses so that there are established passages 32 extending between the elements 14 radially outwards to the exterior surface of the assembly of plate elements 14, whereat they form flame ports 34. Increasing or decreasing the differential also increases and decreases the size of the flame ports. In use, the gas air mixture issuing from these flame ports is ignited so as to form the flames 36.

[0029] To enable the fan 22 to be coupled effectively to the stack of plate elements 14, appropriate fittings 38 and 40 may be provided, and in addition as shown in Fig. 3, a coupling plate 42 may be provided through which the bolt 12 passes, and which has quadrant shaped apertures 44 to enable the fuel air mixture to pass into the distributor 24. The passage of the gas/air mixture through said apertures also has a beneficial effect on the mixing.

[0030] The burner 10 forms a neat cylindrical assembly around the cylindrical outer wall of which the annular flame 36 is established. As explained herein, such a burner is effective in providing heat for a cylindrical type heat exchanger of the type which is being used more and more in practice.

[0031] The dimensions of the plate elements 14, and feet 30 and the recesses of which they are received will be selected so as to provide passages 32 of the appropriate dimension for effective combustion, and, as shown in Fig. 4, the outer peripheral edges of the plate elements 14 may be profiled as shown at 46 in order to mitigate against any current shedding, and to minimize resonant noise, as referred to herein. The profile in 46 in the example of Fig. 4 is the tapering of the extreme edges to a pointed configuration.

[0032] The distributor 24 provides a means whereby the fuel air mixture may be evenly distributed throughout the interior 16, to ensure that equal amounts of fuel and air mixture pass through all of the passages 32, but in alternative arrangements, the same effect can be achieved in a different way.

[0033] In the arrangement of Fig. 5 for example, the plate elements 14 are not identical, but are arranged so that progressively from top to bottom of the stack, the passages 32 are of progressively increasing cross-sectional area so that the pressure of the fuel air mixture in the respective passages will tend to be automatically equalized and equal amounts will flow from the ports 36 without the use of the distributor.

[0034] In the arrangement of Fig. 4 on the other hand, a solid inverted cone 50 is connected to the underside of the cover 18, so as to create a pressure gradient inside the interior 16 which will have the effect of causing equal amounts of fuel air mixture to be expelled through the passages 32, without the use of perforated distributor. The cone and the top cap may be cast in one piece as a single element.

[0035] The essential feature of the present invention is the utilization of stacked plate elements, preferably of a ceramic material, or the distribution outwardly and transversely of the stack height of the fuel air mixture so as to establish a peripheral burner flame which can be applied to the heat exchange tubes in a cylindrical type heat exchanger.

[0036] Refering finally to Figures 7 and 8, there is shown an alternative embodiment of plate element 100 having protrusions 102 disposed substantially annularly on a surface 106 of said plate clement. The annulus around which said protrusions 102 are disposed is shown in dotted line and has a mean radius R_1, whereas protrusions 104 are disposed within a second annulus disposed on the surface 106 and having a means radius R_2. It is immediately evident from the Figure that $R_2>R_1$.

[0037] It is to be mentioned that the gaps between the protrusions around the respective annulus in which they are disposed is shown in the Figure as being large for the purposes of clarity. In practice the gaps between protrusions in either annulus will be much smaller that the protrusions themselves such that the gas flow therethrough is to some extent restricted.

[0038] In Figure 8, it can be seen how the protrusions of one element 100, which are optionally received by recesses (not shown in Figure 8) provided in the surface 108 of an adjacent plate element 110, cooperate with said surface 108 to define a gas distribution channel 112 therebetween. The provision of such a gas distribution channel obviates the requirement for a specific gas distributor within the hollow interior of the burner defined by the stacked plate elements. Furthermore there is no requirement to stack the plate elements in any particular order as there is when the protrusions of different plate elements are of a different height, and finally, depending on the particular configuration of the protrusions and gaps, the plates may be randomly orientated with respect to one another without a requirement for recesses in one surface of the elements to receive the protrusions of an adjacent element. A bumer comprised of such plate elements can be constructed extremely quickly and with a minimum requirement for skilled labour or training.

[0039] It may also be possible to provide apertures through the thickness of the plate elements such that the different gas distribution channels formed between adjacent plate elements are in communication with one another allowing gas to flow therebetween. This may result in improved overall gas distribution prior to exit of said gas through the flame ports.

Claims

1. A gas burner comprising a plurality of annular plate elements stacked to form at least a part of the burner body and to define therein a hollow interior, said interior being adapted to receive a combustible gas/air mixture supplied through one end of the stack, the stack defining a plurality of passages which lead in a direction transverse to the stack height from the interior to flame ports on the outside of the body, characterised in that the plate elements are provided with complementary protrusions and recess on opposite faces, said protrusions being received in the recesses of an adjacent plate element to correctly orientate said plate elements with respect to one another and to separate the plates from one another to define a passage through which the gas/air mixture can flow.

2. A gas burner according to claim 1 characterised in that the plates are substantially planar.

3. A gas burner according to either of claims 1 or 2 characterised in that the plates are made of heat resistant ceramic material.

4. A gas burner according to any of the preceding claims characterised in that the plate elements have feet on one side and recesses on the other side, in which the feet of the adjacent element sit, the feet being of a length greater than the depth of the recesses such that the elements are stacked but spaced one relative to the other.

5. A gas burner according to any of the preceding claims characterised in that the stack is closed by a closure cap and the elements are held together by using a through bolt arrangement.

6. A gas burner according to any of the preceding claims characterised in that the elements are circular in shape so that the stack outer surface is circular, whereby a cylindrical flame is established when the burner is in use.

7. A gas burner according to any of the preceding claims characterised in that the burner is fan powered for the supply of air for the combustible mixture.

8. A gas burner according to any of the preceding claims characterised in that the edges of the elements are shaped or profiled to eliminate eddy current shedding from the gas/air mixture at the passage edge and minimize combustion resonance.

9. A gas burner according to any of the preceding claims characterised in that the interior of the body includes a distributor to ensure that the gas/air mixture is evenly distributed throughout the length of the stack, so that as far as possible, even amounts of gas/air mixture reach all of the passages and flame ports throughout the height of the stack.

10. A gas burner according to any claim 9 characterised in that the distributor comprises a perforated metal tube having an open end and a closed end, the open end being located at the end at which the gas/air mixture is supplied to the interior, so the mixture is initially supplied to the inside of the distributor tube, from whence it emerges into the interior of the body before being forced through the passages to the flame ports.

11. A gas burner comprising a plurality of annular plate elements stacked to form at least a part of the burner body and to define therein a hollow interior, said interior being adapted to receive a combustible gas/air mixture supplied through one end of the stack, the stack defining a plurality of passages which lead in a direction transverse to the stack height from the interior to flame ports on the outside of the body, characterised in that the plate elements are provided with a plurality of protrusions on one surface having gaps therebetween, said protrusions cooperating with the surface of an adjacent element to at least partially define the flame ports, and in that the protrusions separate adjacent plate elements from one another.

12. A gas burner according to claim 11 characterised in that the protrusions are disposed substantially annularly on one surface of the element.

13. A gas burner according to claim 11 or 12 characterised by the features of any of claims 1-11.

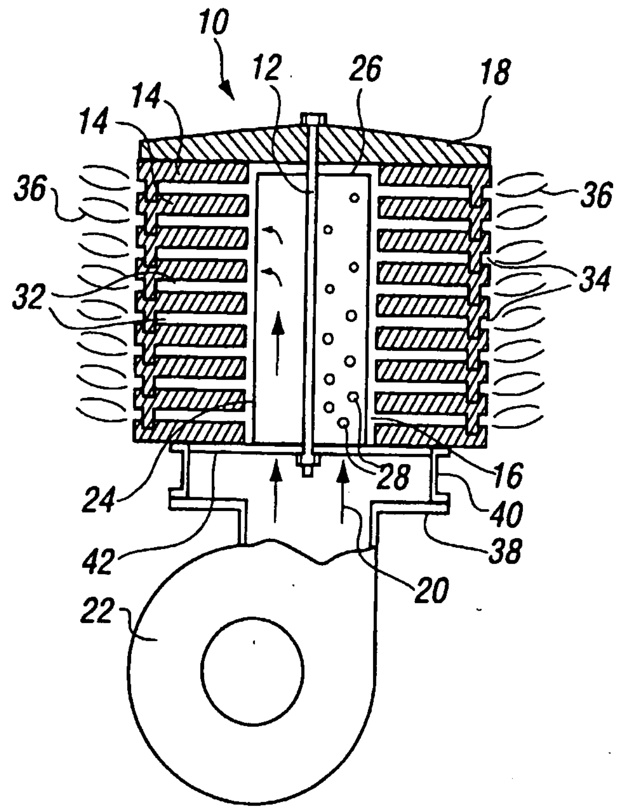

FIG 1

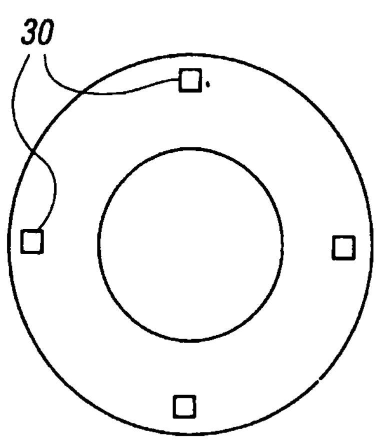

FIG 2

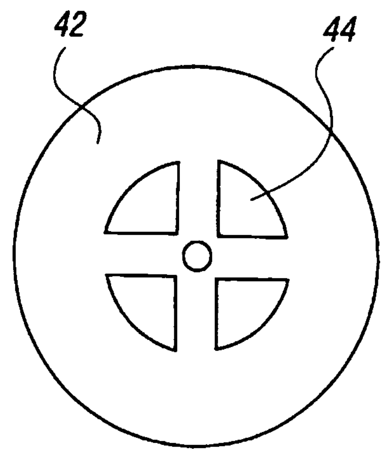

FIG 3

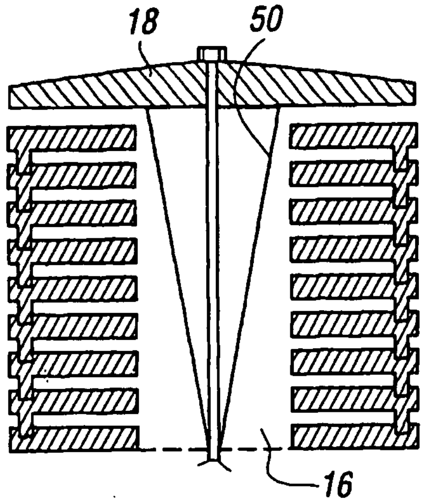

FIG 4

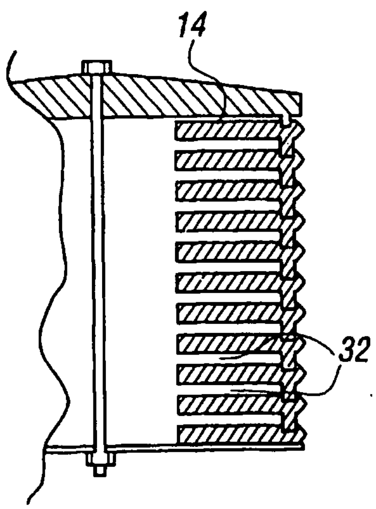

FIG 5

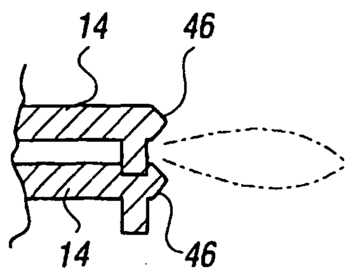

FIG 6

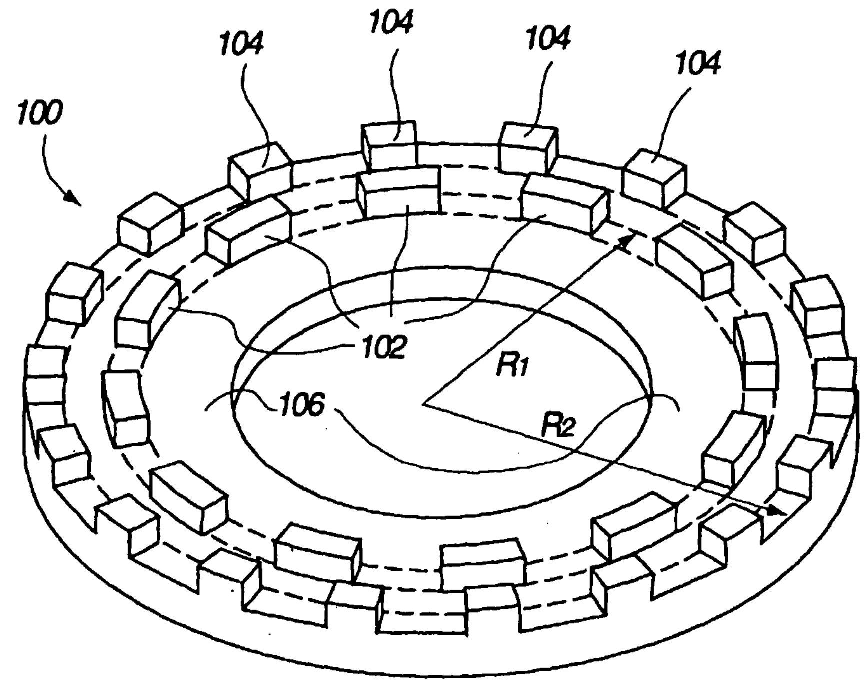

FIG 7

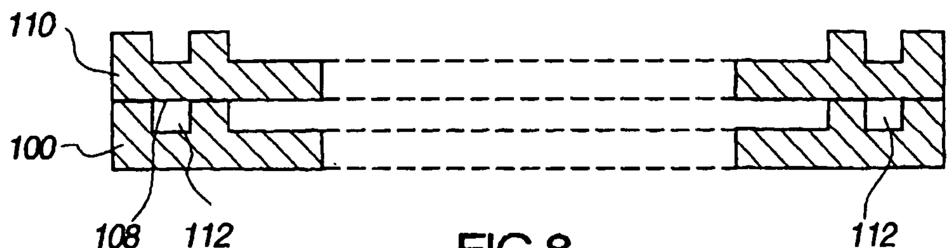

FIG 8